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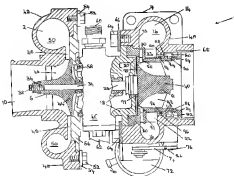
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(54) Title: TURBOCHARGER APPARATUS



(57) Abstract: Variable turbocharger apparatus (2) comprising a housing (4), a compressor (6) mounted for rotation in the housing (4), a turbine (8) mounted for rotation in the housing (4), a first inlet (10) for enabling air to be conducted to the compressor, an outlet (12) for enabling air from the compressor to be conducted to an engine, a second inlet (14) for enabling exhaust gases from the engine to be conducted to the turbine (8) in order to rotate the turbine (8), a chamber (16) which surrounds the turbine (8) and which receives the exhaust gases from the second inlet (14) before the exhaust gases are conducted to the turbine (8), and a bearing assembly (18) for permitting the rotation of the turbine (8), the variable turbocharger apparatus (2) comprising fixed vanes (22) which are mounted in the chamber (16) and which are for accurately directing exhaust gases on to the turbine (8), a piston (24) which is slidable and which is positioned between the vanes and the turbine (8), and control means (26) which is connected to the piston (24) and which is for controlling the sliding movement of the piston (24), the piston (24) having an end (28) which is nearest the bearing assembly (18) and which defines a gap (30), the size of the gap (30) being variable in dependence upon the sliding of the piston (24) under the control of the control means (26), and the size of the gap (30) being effective to control the amount of the exhaust gases that act on the turbine (8) thereby accurately controlling the speed of rotation of the turbine (8) and thereby the amount of air conducted by the compressor through the outlet (12) to the engine, and the end (28) of the piston (24) being such that it has a flange (91) which extends radially outwardly and which is provided with slots (123, 127) for receiving the vanes (22).

WO 03/023194 A1

TURBOCHARGER APPARATUS

This invention relates to turbocharger apparatus and, more especially, this invention relates to variable turbocharger apparatus.

Variable turbocharger apparatus is known comprising a housing, a compressor mounted for rotation in the housing, a turbine mounted for rotation in the housing, a first inlet for enabling air to be conducted to the compressor, an outlet for enabling air from the compressor to be conducted to an engine, a second inlet for enabling exhaust gases from the engine to be conducted to the turbine in order to rotate the turbine, a chamber which extends around the turbine and which receives the exhaust gases from the second inlet before the exhaust gases are conducted to the turbine, a bearing assembly for permitting the rotation of the turbine, and a heat shield for shielding the bearing assembly from the exhaust gases. This known type of variable turbocharger apparatus may require the use of a non-standard bearing assembly, which increases manufacturing costs. Also, gas leakage can be a problem.

It is an aim of the present invention to obviate or reduce the above mentioned problems.

Accordingly, in one non-limiting embodiment of the present invention there is provided variable turbocharger apparatus comprising a housing, a compressor mounted for rotation in the housing, a turbine mounted for

rotation in the housing, a first inlet for enabling air to be conducted to the compressor, an outlet for enabling air from the compressor to be conducted to an engine, a second inlet for enabling exhaust gases from the engine to be conducted to the turbine in order to rotate the turbine, a chamber which surrounds the turbine and which receives the exhaust gases from the second inlet before the exhaust gases are conducted to the turbine, and a bearing assembly for permitting the rotation of the turbine, the variable turbocharger apparatus comprising fixed vanes which are mounted in the chamber and which are for accurately directing exhaust gases on to the turbine, a piston which is slidable and which is positioned between the vanes and the turbine, and control means which is connected to the piston and which is for controlling the sliding movement of the piston, the piston having an end which is nearest the bearing assembly and which defines a gap, the size of the gap being variable in dependence upon the sliding of the piston under the control of the control means, and the size of the gap being effective to control the amount of the exhaust gases that act on the turbine thereby accurately controlling the speed of rotation of the turbine and thereby the amount of air conducted by the compressor through the outlet to the engine.

The variable turbocharger apparatus of the present invention is able to use a standard bearing assembly, and it is also able to substantially eliminate gas leakage in the region of the vanes.

The variable turbocharger apparatus of the present invention may be such that the end of the piston has a flange which extends radially outwardly and which is provided with slots for receiving the vanes. The flange on the end of the piston forms a control ring that operates over the vanes. By using the flange, the exhaust gases are guided more accurately through the vanes onto the turbine. Thus the flange enables the performance of the variable turbocharger apparatus to be enhanced. Pressure on the back face of the flange helps to keep the piston in a closed position, so that a smaller sized control means may be used. Gas leakage through the slots where the vanes are located is not a problem with the variable turbocharger apparatus of the present invention because gas pressure is the same both sides of the flange. During use of the variable turbocharger apparatus, if a carbon deposit builds up on the vanes, then this is cleaned off as the flange of the piston moves backwards and forwards over the vanes. Gas leakage is prevented when the piston is in its closed position. When the piston is in its closed position, this is the most vulnerable time for gas leakage. However, with the variable turbocharger apparatus of the present invention, all the gases are guided accurately through the vanes, the heat shield and the flange as required.

The variable turbocharger apparatus may include a heat shield for shielding the bearing assembly from heat from the exhaust gases. The heat shield may be a ring-shaped heat shield. Alternatively, the heat shield may

be a disc shaped heat shield having an outer ring portion, an inner wall portion, and an aperture through the inner wall portion.

The fixed vanes may be mounted on the heat shield.

The variable turbocharger apparatus of the present invention may include an insert located in the housing, and may be one in which the vanes are mounted on the insert. When the variable turbocharger apparatus includes the insert, then the flange may or may not be present as may be desired.

The insert may be a removable insert which is removable from the housing, the removable insert being such that it facilitates assembly of the variable turbocharger apparatus.

The removable insert may be held in position by a spring. The spring may be such that it forms a seal for preventing gas leakage from the chamber which surrounds the turbine. The spring may be advantageous for manufacture and assembly of the variable turbocharger apparatus in that it reduces tolerance requirements.

If desired, the insert may be a non-removable insert which is not removable from the housing.

The variable turbocharger apparatus may be one in which the piston passes through a bore in the insert.

The variable turbocharger apparatus may be one in which the fixed vanes are mounted on a part of the housing which is adjacent the bearing assembly and which defines an exit from a chamber.

Advantageously, the piston has a first abutment for forming a seal against a mating surface thereby to prevent loss of the exhaust gases between the abutment and the mating surface. The mating surface may be a mating surface on a part of the housing. Alternatively, the mating surface may be a mating surface on an insert in a part of a housing.

The variable turbocharger apparatus may be one in which the piston has a second abutment for engaging against the end of the vanes, thereby setting the gap when the piston is in its closed position.

The variable turbocharger apparatus may include a sealing ring for forming an auxiliary seal for preventing loss of any of the exhaust gases that pass between the first abutment and the mating surface.

The control means may include a fork member which is connected to the piston on two opposed sides. Alternatively, the control means may include a U-shaped member which is connected to the piston on a face of the piston.

The variable turbocharger apparatus may be one in which the slots are open slots which extend inwardly from a periphery of the flange, or closed slots in the flange.

The control means will be an electronic control means which operates as part of an engine management control system. The control system may also use an air or oil operated actuator control means in conjunction with the engine management system.

The variable turbocharger may be one in which the chamber is a volute. Various types of chamber may be employed, for example of various cross sectional shapes.

Embodiments of the invention will now be described solely by way of example and with reference to the accompanying drawings in which:

Figure 1 is a section through first variable turbocharger apparatus with a piston in a closed position;

Figure 2 is a section like Figure 1 but through second variable turbocharger apparatus and with a piston in a fully open position;

Figure 3 is a section like Figure 1 but through third variable turbocharger apparatus and with a piston in a closed position:

Figure 4 is a section like Figure 1 but through fourth variable turbocharger apparatus and with a piston in a closed position;

Figure 5 is a section like Figure 1 but through fifth variable turbocharger apparatus and with a piston in a closed position;

Figure 6 is a side view of the first turbocharger apparatus shown in Figure 1 and illustrates control means having a fork member which is connected to the piston on two opposed sides of the piston;

Figure 7 is a section through the heat shield shown in the first variable turbocharger apparatus of Figure 1;

Figure 8 is an end view of the heat shield shown in Figure 7;

Figure 9 is the section through a piston which is like the piston shown in Figure 5 but which is for use with control means of the type shown in Figures 1, 2 and 6;

Figure 10 is an end view of a flange part of the piston shown in Figure 9, the flange having slots for vanes;

Figure 11 is an end view of a control ring fixed to the end of a piston, the control ring having slots extending inwardly from a periphery of the control ring;

Figure 12 is an end view of a control ring where the slots are completely within the control ring;

Figure 13 is a side view of the piston shown in Figures 1 and 2, and illustrates how the control ring shown in Figures 11 and 12 may be fitted to the piston;

Figure 14 is a section through sixth variable turbocharger apparatus of the present invention;

Figure 15 is a section through seventh variable turbocharger apparatus of the present invention;

Figure 16 is a section through eighth variable turbocharger apparatus of the present invention;

Figure 17 is a section through ninth variable turbocharger apparatus of the present invention;

Figure 18 is a side view of the piston used in the variable turbocharger apparatus shown in Figures 14 – 16; and

Figure 19 is an end view of the piston as shown in Figure 18.

Referring to Figure 1, there is shown variable turbocharger apparatus 2 comprising a housing 4 a compressor 6 mounted for rotation in the housing 4, and a turbine 8 which is also mounted for rotation in the housing 4. The variable turbocharger apparatus 2 also comprises a first inlet 10 for enabling air to be conducted to the compressor 6, and an outlet 12 for enabling air from the compressor 6 to be conducted to an engine (not shown).

The variable turbocharger apparatus 2 has a second inlet 14 for enabling exhaust gases from the engine to be conducted to the turbine 8 in order to rotate the turbine 8. A chamber 16 extends around the turbine 8 and receives the exhaust gases from the second inlet 14 before the exhaust gases are conducted to the turbine 8.

A bearing assembly 18 permits the rotation of the turbine 8. A heat shield 20 is provided for shielding the bearing assembly 18 from heat from the exhaust gases.

The variable turbocharger apparatus 2 comprises fixed vanes 22 which are mounted in the chamber 16 and which are for accurately directing the exhaust gases on to the turbine 8. A piston 24 is positioned between the fixed vanes 22 and the turbine. The piston 24 is a slideable piston. Control means 26 control the sliding movement of the piston 24.

The piston 24 has an end 28 which is adjacent the heat shield 20. This end 28 is spaced apart from the heat shield by a gap 30. Figure 1

shows the piston 24 in a closed position in which the gap 30 is at its smallest condition. The size of the gap 30 is variable in dependence upon the sliding of the piston 24. The sliding of the piston 24 is under the general control of the control means 26. The size of the gap 30 is effective to control the amount of the exhaust gases that acts on the turbine 8, thereby accurately controlling the speed of rotation of the turbine 8 and thereby the amount of air conducted by the compressor through the outlet 12 to the engine.

As shown in Figure 1, the variable turbocharger apparatus 2 also comprises a shaft 32 on which the turbine 8 and the compressor 6 are mounted. The compressor 6 is secured to a reduced diameter end portion 34 of the shaft 32 by a nut 36 which screws on to a screw threaded portion 38 on the end portion 34 of the shaft 32.

The turbine 8 has a central body portion 40 and vanes 42. The compressor 6 has a central body portion 44 and vanes 46.

Compressed air from the compressor 6 passes along a diffuser passage 48 into a chamber 50 in the form of a volute as shown. The chamber 16 feeding the exhaust gases to the turbine 8 is also in the form of a volute as shown.

Bolts 52 bearing on washers 54 secure a back plate 56 to a part of the housing 4 that is for the compressor 6. Bolts 58 go into the bearing assembly 18 to hold the back plate 56 in position.

The bearing assembly 18 has an oil intake 60 for providing oil for the bearing assembly 18. Also provided is an oil drain 62.

Bolts 64 act on a clamping plate 66 to clamp the bearing assembly 18 to the part of the housing 4 that is for the turbine 8.

The piston 24 slides against an insert 68 as shown. The insert can be made of a corrosion resistance material depending upon the material used for the housing 4. The housing 4 can basically be regarded as being a three part housing comprising a turbine housing 4A, a compressor housing 4B, and a bearing housing 4C.

The control means 26 has an air intake 70 for controlling an actuator member 72. A diaphragm (not shown) in the actuator member 72 is acted upon by the air. The air intake is controlled by an electronic control device (not shown). Movement of the diaphragm causes movement of an arm 74. The arm 74 pivots a rod 76 (see Figure 6). The rod 76 as best shown in Figure 6 is connected to a fork device 78 having a pair of arms 80, 82 each arm 80, 82 has a locator member 84. Each locator member 84 locates in a recess 86 as shown in Figure 1.

As can be seen from Figures 1, the fixed vanes 22 are mounted on the heat shield 20. In an alternative embodiment of the invention, the fixed vanes 22 may be mounted on a part of the housing 4 which is opposite the heat shield 20 and which defines an exit from the chamber 16.

The piston 24 has an abutment 88 for forming a seal against a mating surface 90, thereby to prevent loss of the exhaust gases between the abutment 88 and the mating surface 90. As shown in Figure 1, the mating surface 90 is formed as a part of the housing 4.

The provision of the abutment 88 and the mating surface 90 may be sufficient to prevent the loss of the exhaust gases between the abutment 88 and the mating surface 90. As an extra precaution against the loss of the exhaust gases, a seal 94 is provided. In Figure 1, the seal 94 is provided in an insert 96 in a part of the housing 4. The seal 94 is in the form of a sealing ring and it thus acts to form an auxiliary seal for preventing loss of any of the exhaust gases that might pass between the abutment 88 and the mating surface 90.

The end 28 of the piston 24 has a flange 91. The flange 91 extends radially outwardly as shown. The flange 91 is provided with slots (not shown in Figure 1) for receiving the vanes 22.

The heat shield 20 shown in Figure 1 is a disk shaped heat shield having an outer ring portion 93 and an inner wall portion 95. The inner wall portion 95 has a aperture 97 through which the turbine 8 passes.

Figure 2 is a section through second variable turbocharger apparatus 99. The second variable turbocharger apparatus 99 is similar to the variable turbocharger apparatus 2 shown in Figure 1 and similar parts have been given the same reference numerals for ease of comparison and understanding. In Figure 2, it will be seen that the heat shield 20 does not have the inner wall portion 95. In Figure 2 it will also be seen that the piston 24 is shown in its open position, rather than in its closed position as shown in Figure 1.

Figure 3 shows third variable turbocharger apparatus 101. Figure 4 shows fourth variable turbocharger apparatus 103. Figure 5 shows fifth variable turbocharger apparatus 105. The variable turbocharger apparatus 101 shown in Figure 3, 103 shown in Figure 4 and 105 shown in Figure 5 is similar to the variable turbocharger apparatus 2 shown in Figure 1 and 99 shown in Figure 2. Similar parts have again been given the same reference numerals for ease of comparison and understanding.

In Figure 3 the variable turbocharger apparatus 101 is operated by control means 27 which is similar to the control means 26. The control means 27 is shaped as shown in Figures 3, 4 and 5 and it connects by three arms 29 to a piston 31 as shown in Figure 3, or to a piston 33 as shown in Figure 4, or to a piston 35 as shown in Figure 5. The arms 29 connect to a shaft 37 which connects to the actuator member 72.

In Figure 3, the vanes 22 are cast as part of the heat shield 20. In Figure 4, the vanes 22 are case onto an insert 107. The piston 33 works against the insert 107 as shown in Figure 4.

In Figure 5, the flange 91 is provided with a return portion 109 which is received in a groove 111 as shown.

In Figure 1, the flange 91 is shown in the closed position, with the piston 24 having been moved by the control means 26. The travel of the piston 24 towards its closed position is arrested by a stop portion 113 on the piston 24. Figure 2 shows the piston 24 in the open position. Figure 3 shows the piston 31 in the closed position with the closing movement of the

piston 31 having been stopped when a stop portion 115 of the piston 31 engages the ends of the vanes 22. In Figure 4, a stop portion 117 on the piston 33 engages a flange 119 on the insert 107 in order to stop the inward travel of the piston 33. In Figure 5, a stop portion 121 engages the ends of the vanes 22 in order to stop the inward travel of the piston 35. Figure 4 also shows a design with no heat shield, and with the vanes cast on the insert 107. In order to keep the bearing assembly cool, a water jacket 129 is provided with a water passageway 131.

Figure 6 is an end view of the turbocharger apparatus 2 shown in Figure 1 and illustrates in more detail the location of the actuator member 72.

Figures 7 and 8 show the heat shield 20. The heat shield 20 has fixed vanes 22. The heat shield 20 also has an outer ring portion 93 which is similar in shape to the heat shield 20 shown in Figures 2. However the heat shield 20 also has the inner wall portion 95 which provides additional heat shielding facilities for the bearing assembly 18.

Figures 9 and 10 show a piston 104 which is like the piston 35 shown in Figure 5 but which uses the control means 26 shown in Figure 1. Although not shown in Figure 9, the piston 104 may be provided with a pin to stop rotation of the piston 104 during use of the variable turbocharger apparatus. Figure 9 also shows the piston 104 provided with a groove 86 to connect to the fork device 78 shown in Figure 6. Figure 10 is an end view of the piston flange, and shows the slots for the vanes.

Figure 11 shows a design for a piston flange 121. Slots 123 are cut into the flange 121 from the outer periphery of the flange 121 as shown. This design may be an economically way to produce the flange 121. The flange 121 and be formed as a separate ring which can secured to the remainder of the piston 24 by a weld 125 as shown in Figure 13. Alternatively, the weld 125 can be a peen or a screw. Figure 12 shows how slots 127 may alternatively be completely formed in the flange 121. Again the flange 121 shown in Figure 12 may be formed as a separate ring for attachment to the remainder of the piston 24 as shown in Figure 13.

Referring now to Figures 14 – 18, similar parts as in previous Figures have been given the same reference numerals for ease of comparison and understanding. In Figure 14, there is shown variable turbocharger apparatus 150 having an insert 152 on which the fixed vanes 22 are mounted. The insert 152 is removable from the turbine housing 4. A disc spring 154 is used to push the insert 152 to the left as shown in Figure 14 and over and against the bearing assembly 18. The disc spring 154 is also used as a seal for preventing gas leakage.

As also shown in Figure 14, an abutment in the form of a stop ring 156 is employed to set the start gap 30 over the turbine wheel. The stop ring 156 abuts against a small lip 158 on the piston 24. The stop ring 156 may be spot welded, crimped or otherwise held in position. When the stop ring 156 is set against the lip 158, the stop ring 156 may then prevent all of the gas leakage from passing through the piston 24 when the piston 24 is in

the closed position and thus when the piston 24 is pushed against the insert 152.

The variable turbocharger 150 shown in Figure 14 allows the piston 24, the insert 152 and the stop ring 156 to be assembled as an assembly into the turbine housing 4A. The disc spring 154 also acts as a seal to prevent gas leakage passing the volute area of the variable turbocharger apparatus 150, so that all the gases are used on the turbine wheel and thereby performance is improved.

Figure 15 shows variable turbocharger apparatus 160 which is like the variable turbocharger apparatus 150 shown in Figure 14. In the variable turbocharger apparatus 160, the bearing assembly 18 has a heat shield 20 for helping to prevent heat build up in the bearing area. This particular design may be employed in variable turbocharger apparatus that is designed to run hotter than usual. Figure 15 also shows the use of a seal 162 in the insert 152. The seal 162 is for preventing gas leakage when the piston 24 is in its open position.

As shown in both Figure 14 and 15, the stop ring 156 prevents all gas leakage passing the piston 24 when the piston 24 is in its closed position, since this is the most difficult part of the operating range of the turbocharger apparatus for being able to achieve good performance.

Figure 16 shows variable turbocharger apparatus 164 which is like the variable turbocharger apparatus 150 and 160. As shown in Figure 16, the variable turbocharger apparatus 164 has an insert 152 with the fixed

vanes 22. However this insert 152 has screw threads 166 which allow the insert 152 to be screwed into the turbine housing 4. The screw threads 166 provide a sealing function, whilst at the same time allowing the insert 152 to be located in position in the turbine housing 4A. The use of the screw threads 166 also allows the assembly of the insert 152, the piston 24 and the stop ring 156 to be screwed into the turbine housing 4A as one single unit.

Referring now to Figure 17, there is shown variable turbocharger apparatus 168 having an insert 152, vanes 22, a piston 24 and a flange 170. The piston 24 also has a stop ring 172 which is designed as shown with a groove 174. The stop ring 172 is used to allow a fork member 78 to be connected to the stop ring 172, and to move the piston 24 and the stop ring 172 in the variable turbocharger apparatus 168. The stop ring 172 sets the gap 30 when the piston 24 is in its closed position. When the actuator 72 moves the control rod 74, this in turn moves a fork 78 that controls the movement of the piston 24. The variable turbocharger apparatus 168 shown in Figure 17 enables hot gases to be prevented from working on the fork member 78 and its associated parts by having a longer piston 24. As shown in Figure 17, this longer piston 24 operates to shield the fork member 78 from the hot gases.

Figure 17 also shows that the turbine housing 4 is machined to provide an air gap 178. The air gap 178 is positioned between the bearing assembly 18 and the turbine housing 4A. With this arrangement, a heat

shield is not required because the turbine housing 4A also acts as a heat shield. The design of the variable turbocharger apparatus 168 shown in Figure 17 also allows for the piston 24, the insert 152 and the stop ring 172 to be fitted into the turbine housing 4A as an assembly. Figure 17 further shows the use of clamps 179 for clamping the turbine housing 4A to the bearing assembly 18.

Figures 18 and 19 show the piston 24 used in the variable turbocharger apparatus shown in Figures 14, 15 and 16. As can be seen from Figure 18, there are arms 180 that hold the control rod 182 that connects to the actuator that moves the piston 24. Also shown in Figure 18 is the step 158 for the stop ring 156 so that when the stop ring 156 is set against the step 158 and appropriately fixed in position, for example by welding or crimping, gas leakage is stopped when the piston 24 is in its closed position. Also this piston 24 may be stamped or formed as a single unit so the piston and flange are made as one part.

Figure 19 best illustrates how the slots 184 for the vanes 22 are open ended slots. With variable turbocharger apparatus of the invention with a flange on the end of the piston, and with the vanes going through the slots in the flange, the performance of the variable turbocharger apparatus may be greatly increased. Also, the flange keeps the vanes clean when moving along the vanes. The vanes and the slots prevent rotation of the piston. Where the variable turbocharger apparatus of the present invention employs an insert, then insert with the vanes is utilised for guiding gases to the

turbine wheel. The insert allows for the piston to work inside the bore of the insert between the vanes and turbine wheel. The use of a removable insert which is removable from the turbine housing allows for assembly of the piston into the turbine housing of the variable turbocharger apparatus. The variable turbocharger apparatus may be unique in its use of a spring to hold the insert and prevent gas leakage, in its use of an insert that is screwed into the turbine housing and that allows the piston assembly to be assembled as a unit in the turbine housing, in the use of an insert that is removable in order to allow part of a piston assembly to seal against the insert to prevent gas leakage, and in the use of an insert that is removable and which allows part of a piston assembly to locate on a side of the insert so as to set the gap of the end of the piston over the turbine wheel.

The different variations of the variable turbocharger apparatus of the present invention and shown in the accompanying drawings is able to work efficiently and to be manufactured economically. The gap 30 is able to be varied by the sliding piston 24. Where a flange on the end of the piston is employed, then the flange forms a control ring that slides over the vanes. By using the flange, the exhaust gases are guided more accurately through the vanes onto the turbine. Thus, the performance of the variable turbocharger apparatus is enhanced. Pressure on the back face of the flange helps to keep the piston in a closed position, so that a smaller sized control means may be used. Gas leakage through the slots where the vanes are located is not a problem with the variable turbocharger apparatus

of the present invention because gas pressure is the same both sides of the control ring. During use of the variable turbocharger apparatus, if a carbon deposit builds up on the vanes, then this is cleaned off as the flange of the piston moves backwards and forwards over the vanes, with the vanes passing through the slots in the flange. Gas leakage is prevented when the piston is in its closed position. When the piston is in its closed position, this is the most vulnerable time for gas leakage. However, with the variable turbocharger apparatus of the present invention, all the gases are guided accurately through the vanes, the heat shield and the flange in order to work on the turbine as required.

It is to be appreciated that the embodiments of the invention described above with reference to the accompanying drawings have been given by way of example only and that modifications may be effected. Thus, for example, the shape of the chambers 16 and 50 may be varied. Also, the number of vanes may vary, and the sealing rings may be used or not used as may be desired.

CLAIMS

1. Variable turbocharger apparatus comprising a housing, a compressor mounted for rotation in the housing, a turbine mounted for rotation in the housing, a first inlet for enabling air to be conducted to the compressor, an outlet for enabling air from the compressor to be conducted to an engine, a second inlet for enabling exhaust gases from the engine to be conducted to the turbine in order to rotate the turbine, a chamber which surrounds the turbine and which receives the exhaust gases from the second inlet before the exhaust gases are conducted to the turbine, and a bearing assembly for permitting the rotation of the turbine, the variable turbocharger apparatus comprising fixed vanes which are mounted in the chamber and which are for accurately directing exhaust gases on to the turbine, a piston which is slidable and which is positioned between the vanes and the turbine, and control means which is connected to the piston and which is for controlling the sliding movement of the piston, the piston having an end which is nearest the bearing assembly and which defines a gap, the size of the gap being variable in dependence upon the sliding of the piston under the control of the control means, and the size of the gap being effective to control the amount of the exhaust gases that act on the turbine thereby accurately controlling the speed of rotation of the turbine and thereby the amount of air conducted by the compressor through the outlet to the engine.

2. Variable turbocharger apparatus according to claim 1 in which the end of the piston is such that it has a flange which extends radially outwardly and which is provided with slots for receiving the vanes.
3. Variable turbocharger apparatus according to claim 1 or claim 2 and including a heat shield for shielding the bearing assembly from heat from the exhaust gases.
4. Variable turbocharger apparatus according to claim 3 in which the heat shield is a ring-shaped heat shield.
5. Variable turbocharger apparatus according to claim 3 in which the heat shield is a disc shaped heat shield having an outer ring portion, an inner wall portion, and an aperture through the inner wall portion.
6. Variable turbocharger apparatus according to any one of claims 3 – 5 in which the vanes are mounted on the heat shield.
7. Variable turbocharger apparatus according to any one of claims 1 – 5 and including an insert located in the housing, and in which the vanes are mounted on the insert.

8. Variable turbocharger apparatus according to claim 7 in which the insert is a removable insert which is removable from the housing, the removable insert being such that it facilitates assembly of the variable turbocharger apparatus.
9. Variable turbocharger apparatus according to claim 8 in which the insert is held in position by a spring.
10. Variable turbocharger apparatus according to claim 9 in which the spring is such that it forms a seal for preventing gas leakage from the chamber which surrounds the turbine.
11. Variable turbocharger apparatus according to claim 7 in which the insert is a non-removable insert which is not removable from the housing.
12. Variable turbocharger apparatus according to any one of claims 8 – 11 in which the piston passes through a bore in the insert.
13. Variable turbocharger apparatus according to any one of claims 1- 4 in which the vanes are mounted on a part of the housing which is adjacent the bearing assembly and which defines an exit from a chamber.

14. Variable turbocharger apparatus according to any one of the preceding claims in which the piston has a first abutment for forming a seal against a mating surface thereby to prevent loss of the exhaust gases between the abutment and the mating surface.

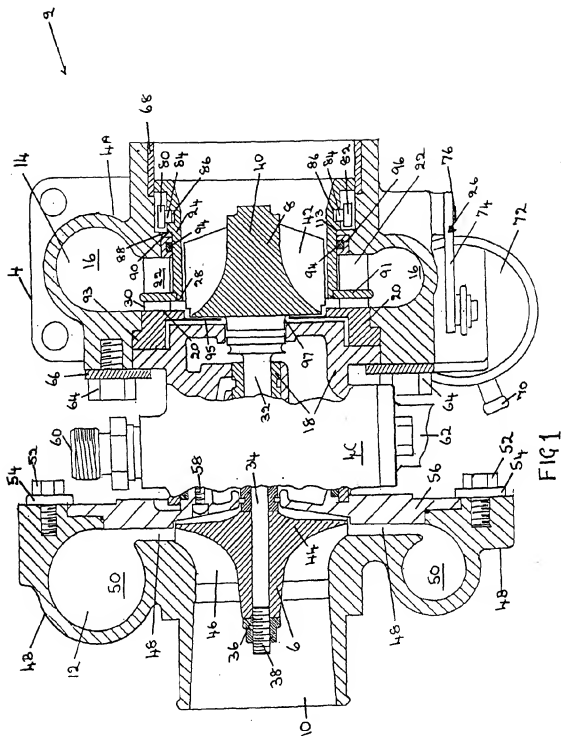
15. Variable turbocharger apparatus according to claim 14 in which the mating surface is a mating surface on a part of the housing.

16. Variable turbocharger apparatus according to claim 14 in which the mating surface is a mating surface on an insert in a part of the housing.

17. Variable turbocharger apparatus according to any one of claims 14 - 16 in which the piston has a second abutment for engaging against the end of the vanes, thereby setting the gap when the piston is in its closed position.

18. Variable turbocharger apparatus according to any one of claims 14 - 17 including a sealing ring for forming an auxiliary seal for preventing loss of any of the exhaust gases that pass between the first abutment and the mating surface.

19. Variable turbocharger apparatus according to any one of the preceding claims in which the control means includes a fork member, which is connected to the piston on two opposed sides.
20. Variable turbocharger apparatus according to any one of claims 1 - 18 in which the control means includes a U-shaped member which is connected to a face of the piston.
21. Variable turbocharger apparatus according to any one of the preceding claims in which the slots are open slots which extend inwardly from the periphery of the flange, or closed slots in the flange.
22. Variable turbocharger apparatus according to any one of the preceding claims in which the control means is an electronic control means which operates as part of an engine management control system.
23. Variable turbocharger apparatus according to any one of the preceding claims in which the chamber is a volute.



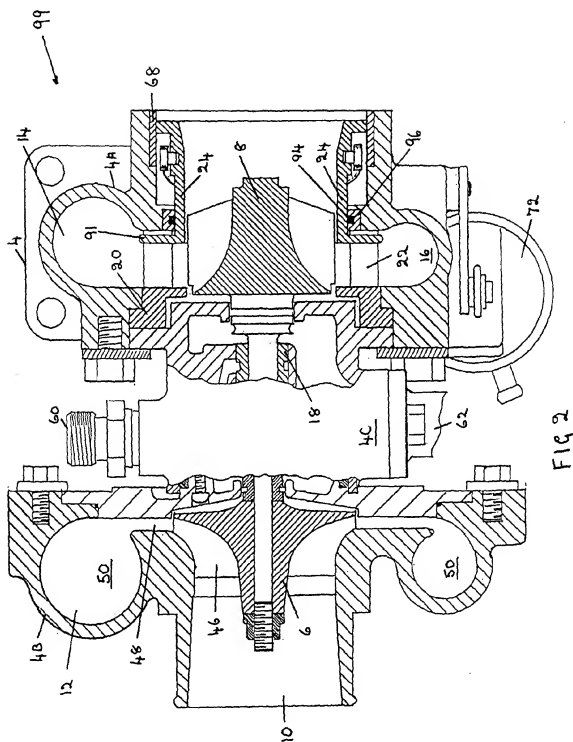
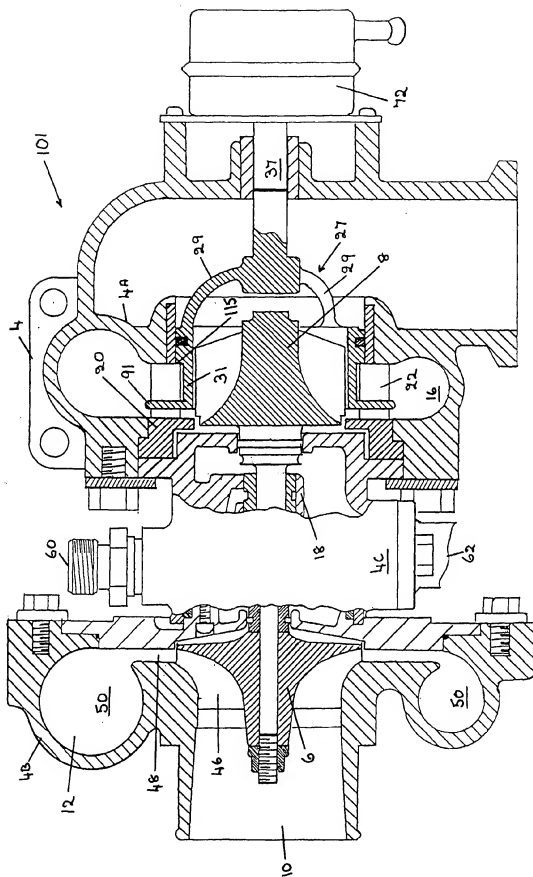
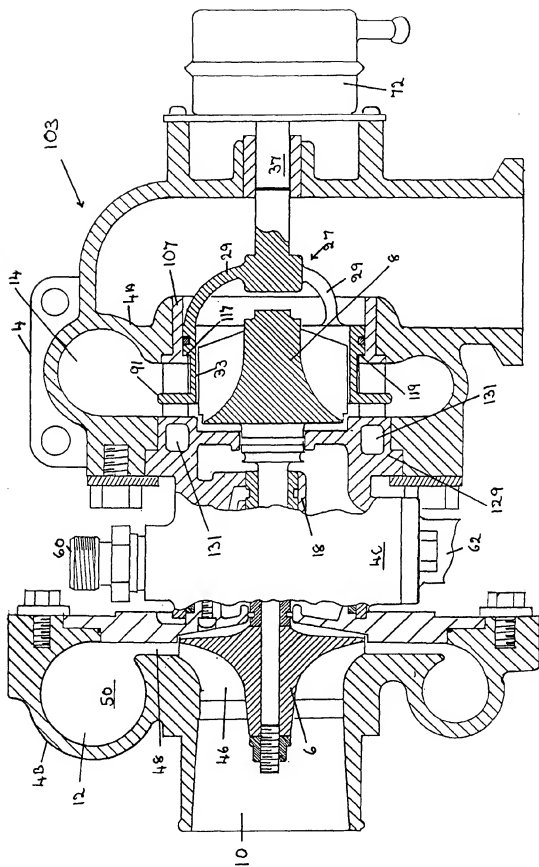


FIG 2





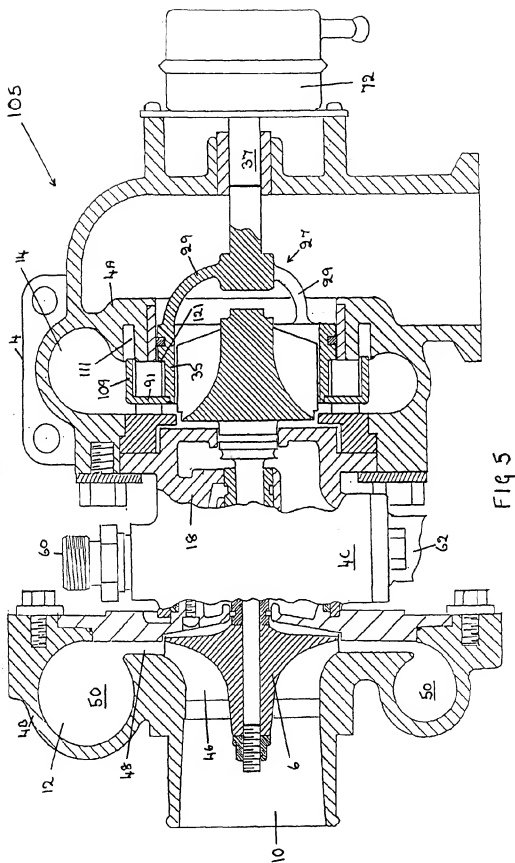


FIG 5

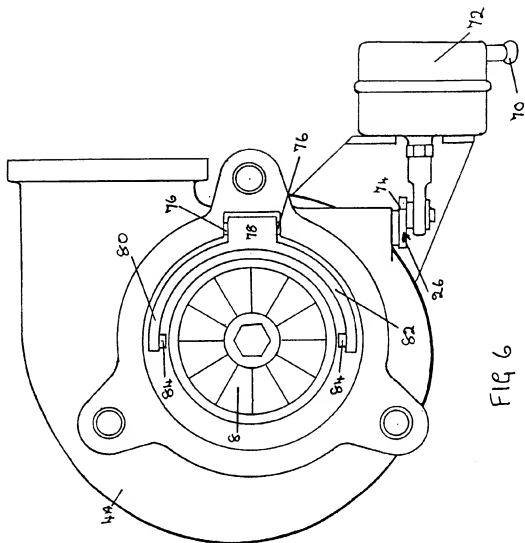


FIG 6

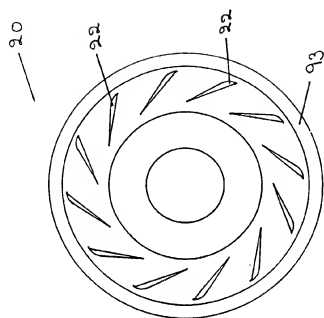


FIG 8

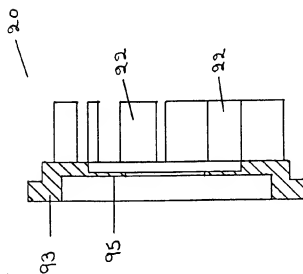


FIG 7

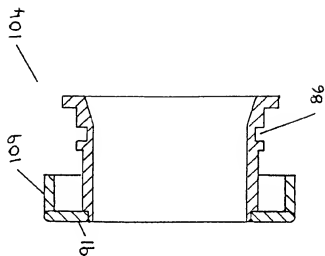


Fig 9

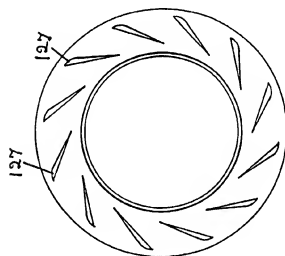


Fig 10

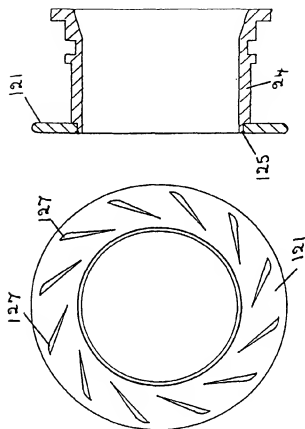
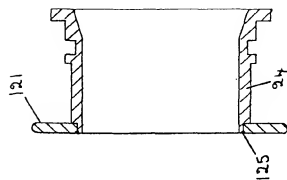
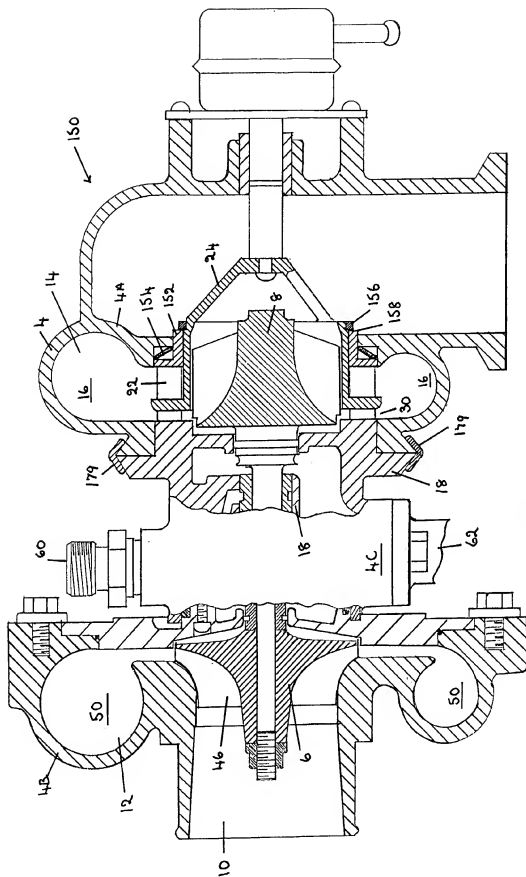


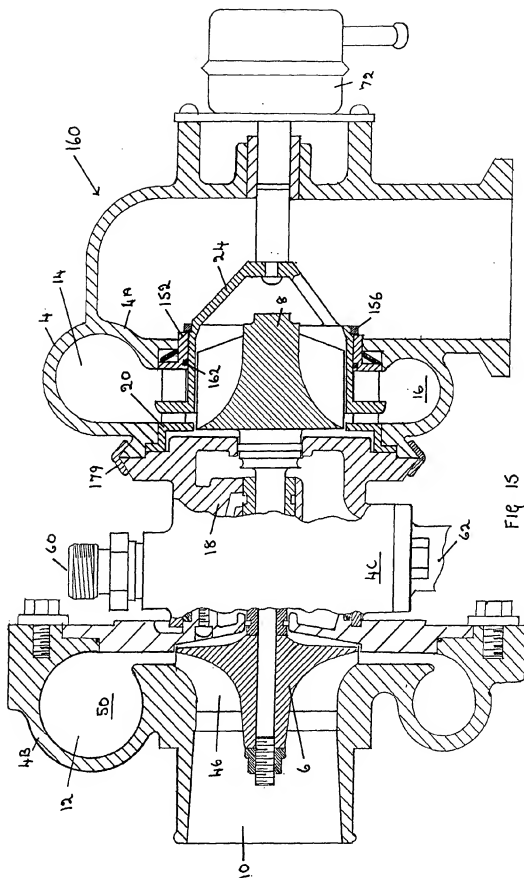
FIG 13

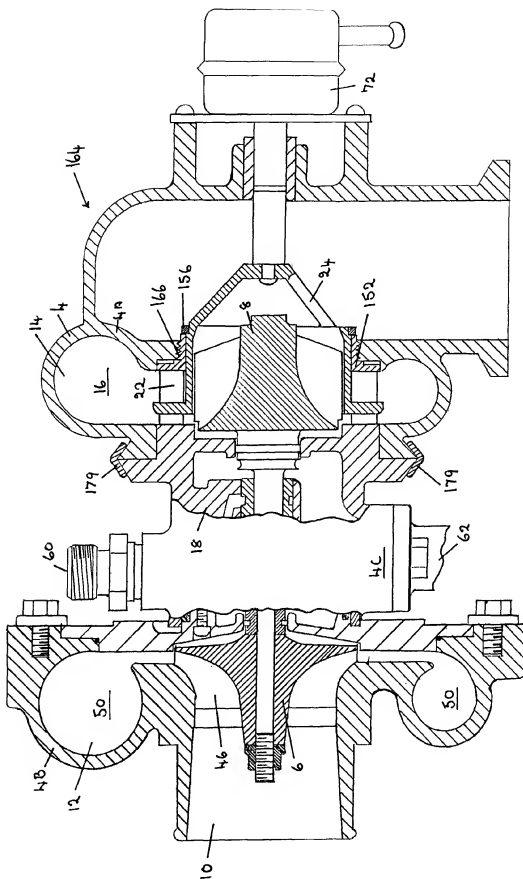
FIG 12

FIG 11









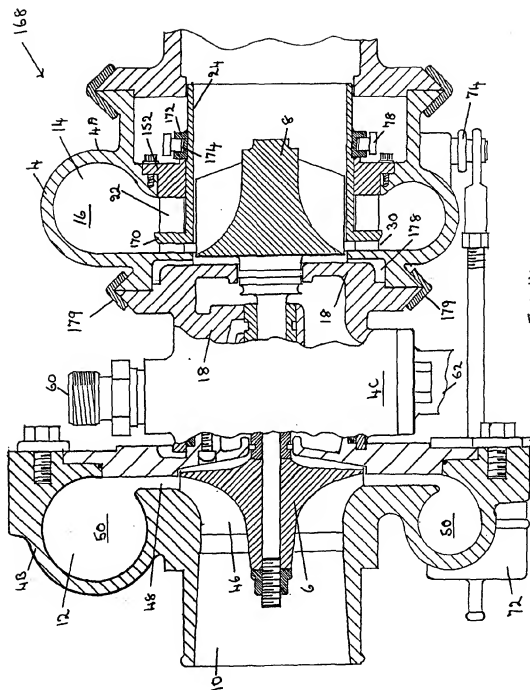


Fig 17

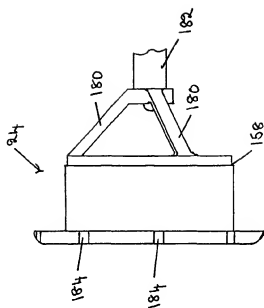


Fig 18

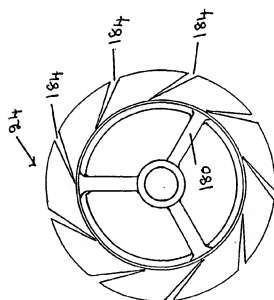


Fig 19

INTERNATIONAL SEARCH REPORT

PCI/GB 02/04094

A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 F01D17/14

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 F01D F02C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 571 205 A (ALLIEDSIGNAL LTD) 24 November 1993 (1993-11-24) column 2, line 35 -column 6, line 13; figures 1,2	1-6, 13, 19, 21, 23
Y	---	7, 8, 20
Y	US 5 214 920 A (LEAVESLEY MALCOLM G) 1 June 1993 (1993-06-01) column 4, line 54 -column 5, line 50; figure 1	7, 8
Y	EP 0 884 453 A (HOLSET ENGINEERING CO) 16 December 1998 (1998-12-16) figure 3	20
	--- -/-	

☒ Further documents are listed in the continuation of box C.☒ Patent family members are listed in annex.

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Date of the actual completion of the international search

28 November 2002

Date of mailing of the international search report

05/12/2002

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 42 18 229 C (MAN B & W DIESEL) 4 March 1993 (1993-03-04) column 3, line 59 -column 4, line 25; figure 3 ---	1,2,7,8, 13,21,23
A	EP 0 034 915 A (HOLSET ENGINEERING CO) 2 September 1981 (1981-09-02) abstract -----	1-23

INTERNATIONAL SEARCH REPORT

PCT/GB 02/04094

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
EP 0571205	A	24-11-1993	DE 69308377 D1	10-04-1997
			DE 69308377 T2	19-06-1997
			EP 0571205 A1	24-11-1993
			JP 6050164 A	22-02-1994
			US 5441383 A	15-08-1995
US 5214920	A	01-06-1993	US 5231831 A	03-08-1993
EP 0884453	A	16-12-1998	GB 2326198 A	16-12-1998
			EP 0884453 A1	16-12-1998
			JP 11072008 A	16-03-1999
			US 5868552 A	09-02-1999
			US 5941684 A	24-08-1999
DE 4218229	C	04-03-1993	DE 4218229 C1	04-03-1993
			JP 3258136 B2	18-02-2002
			JP 6033706 A	08-02-1994
EP 0034915	A	02-09-1981	BR 8101054 A	25-08-1981
			EP 0034915 A1	02-09-1981
			ES 8205932 A1	01-11-1982
			JP 56129705 A	12-10-1981
			PL 229827 A1	18-09-1981